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ENGAGE: A GAME BASED LEARNING AND PROBLEM SOLVING FRAMEWORK

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FINAL TECHNICAL REPORT

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14. ABSTRACT This effort designed a novel way of learning and real-world problem solving by determining the optimal human-computer symbiotic learning and problem solving framework. There are no general methods for discovering optimal learning pathways to bring novices to experts in an area, or how to effectively combine humans and computers in a general framework. Specifically, the effort focused on the problem of critical importance to the military, visual cognitive skills required for Improvised Explosive Device (IED) discovery. The effort used a game-based framework to collect large quantities of data on the possible improvements in the performance of regular people on the low-level visual cognitive tasks of high importance for IED discovery as identified by Joint Improvised Explosive Device Defeat Organization (JIEDDO). IED discovery game provides a venue to assist in teaching/training individuals for real world crisis situations. The effort focused on developing a set of skills necessary to enhance IED-relevant visual skills: anomaly detection, visual perception, and useful field of view. The IED discovery game served both as a teaching tool and as a way to understand how to incorporate those skills into more elaborate IED training tools. The findings showed that even with voluntary play, people improve on psychological tests. On fully controlled tests with pre and post psychological tests we found marked improvement on just 10 hours of play. Specifically, players improved on visual search in terms of time required for the same accuracy of results. The largest effect was found on useful field of view cognitive tasks where people improved their performance up to 30% on controlled tests after 10 hours of play. These findings point out that a targeted adaptive game is a powerful training tool capable of significantly improving low-level visual cognition tasks with only 10 hours of play.					
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Table of Contents

1	SUMMARY	1
2	INTRODUCTION	2
3	METHODS, ASSUMPTIONS, AND PROCEDURES	3
4	RESULTS AND DISCUSSION	4
5	CONCLUSIONS	5
6	LIST OF REFERENCES.....	7
7	LIST OF ACRONYMS	8

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1 SUMMARY

The goal of this task is to design a novel way of learning and real-world problem solving by determining the optimal human-computer symbiotic learning and problem solving frame-work. There are no general methods for discovering optimal learning pathways to bring novices to experts in an area, or how to effectively combine humans and computers in a general framework. The effort specifically focused on problem of critical importance to the military, visual cognitive skills required for Improvised Explosive Device (IED) discovery.

The effort used a game-based framework to collect large quantities of data on the possible improvements in the performance of regular people on the low-level visual cognitive tasks of high importance for IED discovery as identified by Joint Improvised Explosive Device Defeat Organization (JIEDDO). IED discovery game provides a venue to assist in teaching/training individuals for real world crisis situations. The effort focused on developing a set of skills necessary to enhance IED-relevant visual skills: anomaly detection, visual perception, and useful field of view. The IED discovery game served both as a teaching tool and as a way to understand how to incorporate those skills into more elaborate IED training tools.

The findings showed that even with voluntary play people improve on psychological tests. On fully controlled tests with pre and post psychological tests we found marked improvement on just 10 hours of play. Specifically, players improved on visual search in terms of time required for the same accuracy of results. The largest effect was found on useful field of view cognitive tasks where people improved their performance up to 30% on controlled tests after 10 hours of play. These findings point out that a targeted adaptive game is a powerful training tool capable of significantly improving low-level visual cognition tasks with only 10 hours of play.

2 INTRODUCTION

The approach relies on the ability to gather discriminative, nuanced, massive data set on how people approach learning about and solving the problem. Therefore, the effort used a game based framework, as games are an endeavor that people naturally gravitate towards and spend time on. The game framework puts game based problem solving as a principal mechanism for learning and problem solving. The game can continually adapt to data gathered in an interactive process of design and refinement.

In contrast to standard curriculum-based approach, we dynamically optimize for optimal learning and problem solving pathways within a rapidly adapting video game framework. The game-based approach will enable engagement, return, and retention of players. Simultaneously, it provides access to massive amounts of data on learning and problem solving that can be used to discover optimal pathways.

3 METHODS, ASSUMPTIONS, AND PROCEDURES

A team of developers, designers, and artists has developed and deployed a prototype of the IED discovery game. The effort identified the target skills to train with the game and methods for evaluating and initial game mechanics to train skills. The design for the prototype includes maximum flexibility for iterative design and adaption as well as experimentation to discover optimal pathways.



Figure 1: Vampire Vision Screenshots

The effort specifically focused on the problem areas of critical importance to the military, visual acuity skills relevant for IED discovery and detection tasks. The objective was to develop and release a game to perform an adaptive mass-scale randomized trial that determines the best method to train a specific skill set. Meeting the objective was the first step to developing a more general framework for skill training.

The game is called Vampire Vision. A screenshot is shown in Fig. 1. In the game, the player is meant to find vampires hiding amongst humans. The properties that identify vampires constantly change so that the player cannot learn to profile and must generalize their search strategy. There are different types of levels, each with a unique play style that corresponds to a visual perception skill we want to train. Visual perception tests are embedded in the game at various intervals so that we can measure the effect of the game on players' skills.

4 RESULTS AND DISCUSSION

This effort released the game onto a number of distribution portal sites, such as newgrounds.com. The game has been picked up by more distribution portals, with hundreds of new players each day. The game has been played over 600,000 times.

Over time, this effort was able to gather and analyze a variety of data from those players. This data was used to iteratively improve the design of the game.

The effort was able to rapidly deploy multivariate experiments using the game, focusing on such aspects as game mechanics for player retention (such as the effects of including achievements), properties of embedded tests (such as the tradeoff involved in the length of embedded tests), and optimal level progressions (such as the effects of the difficulty increases as players progress through the game). The effort included more, improved, and better parameters to visual tests in the game. The effort integrated a reinforcement learning framework to discover pathways for optimizing these metrics within the game, based on the large amounts of data we can gather.

The game has been greatly improved and polished from its initial release. The game architecture is flexible and allows for a variety of rapid experiments and data gathering and analysis to discover optimal progressions. More game-based mechanics, such as an achievement system, have been added. The game has been refined for a more intuitive, usable interface to attract and retain players.

Features of the “meta-game” have been implemented, such as level selection, that will be more focused toward social gaming sites. The experimentation framework used in the game has been generalized so that it can be applied to more games.

A controlled lab study was carried out by members of Geoffrey M. Boynton’s lab who were not funded by this grant. Through lab experiments, they found the useful field of view (UFOV) test to be the most promising candidate for improvement, as well as the visual search (VS) test. Results of the UFOV test can be seen in Fig. 2 and for the VS test in Fig. 3. It was found that players of the game improved their ability in UFOV tests and their speed in VS tests when compared to a control game by approximately 30%.

Developing and testing improved UFOV and VS tests for deployment remains an open area. These improved tests could then be embedded in the online version of the game for improved evaluation of player skills.

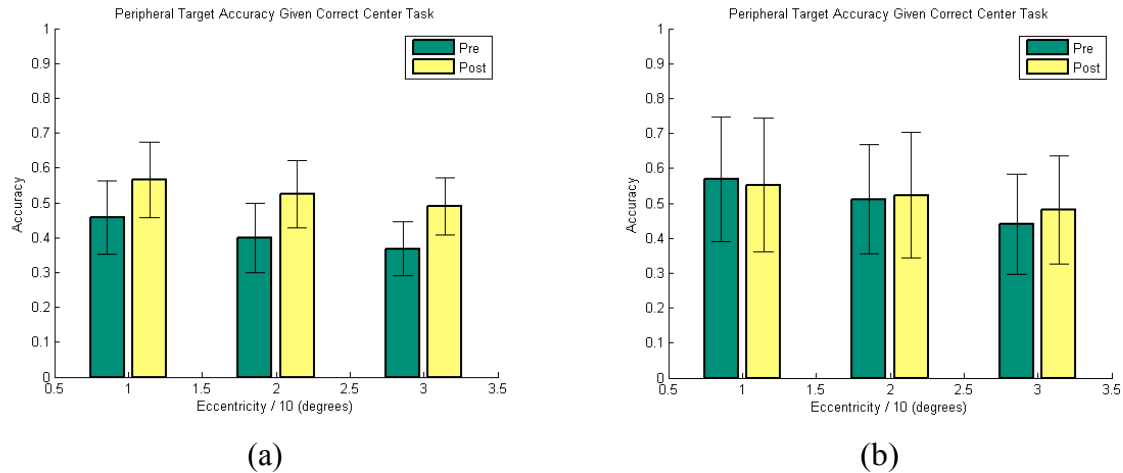


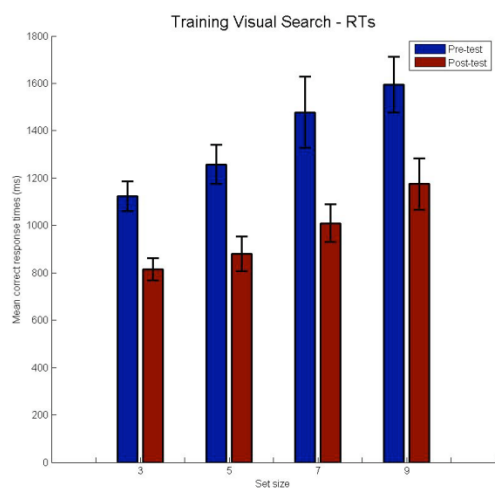
Figure 2: Useful Field of View Comparison

5 CONCLUSIONS

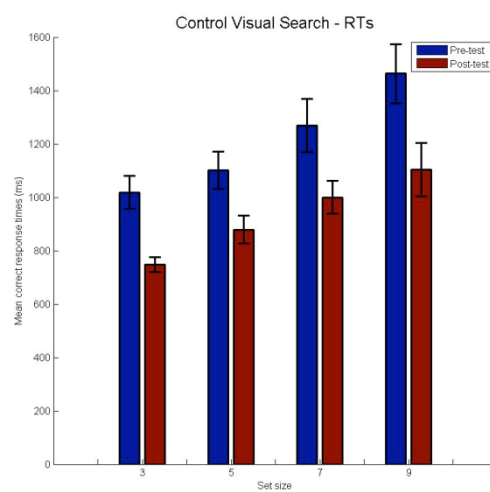
This effort developed a game, Vampire Vision, that focused on training visual perception skills through gameplay and evaluating them with embedded tests. The game was widely deployed on the internet through online gaming portals and found an audience of hundreds of thousands of players. Through a controlled lab study, it was found that the game had impact on useful visual perception skills.

The effort developed a general online experimentation framework which was used to iteratively refine the design of the game. Further, the effort identified the key visual skills and necessary tests to apply this experimentation framework to optimizing skill training in the game.

The findings showed that even with voluntary play people improve on psychological tests. On fully controlled tests with pre and post psychological tests the effort found marked improvement on just 10 hours of play. Specifically, players improved on visual search in terms of time required for the same accuracy of results. The largest effect was found on useful field of view cognitive tasks where people improved their performance up to 30% on controlled tests after 10 hours of play. These findings point out that a targeted adaptive game is a powerful training tool capable of significantly improving low-level visual cognition tasks with only 10 hours of play.



(a)



(b)

Figure 3: Visual Search Comparison.

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7 LIST OF ACRONYMS

IED Improvised Explosive Device

JIEDDO Joint Improvised Explosive Device Defeat Organization